Introduction to Industrial drives

Primer mover of Industry

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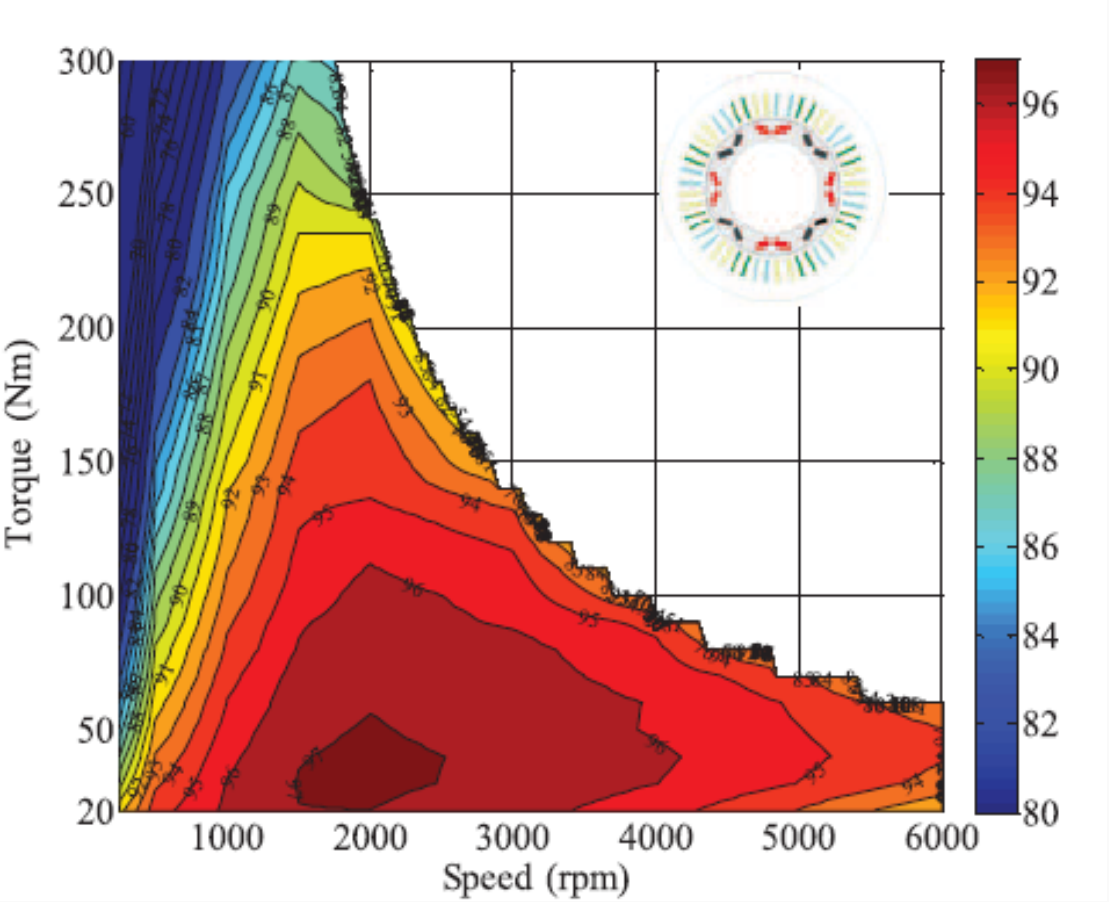


Why Study AC Drive?

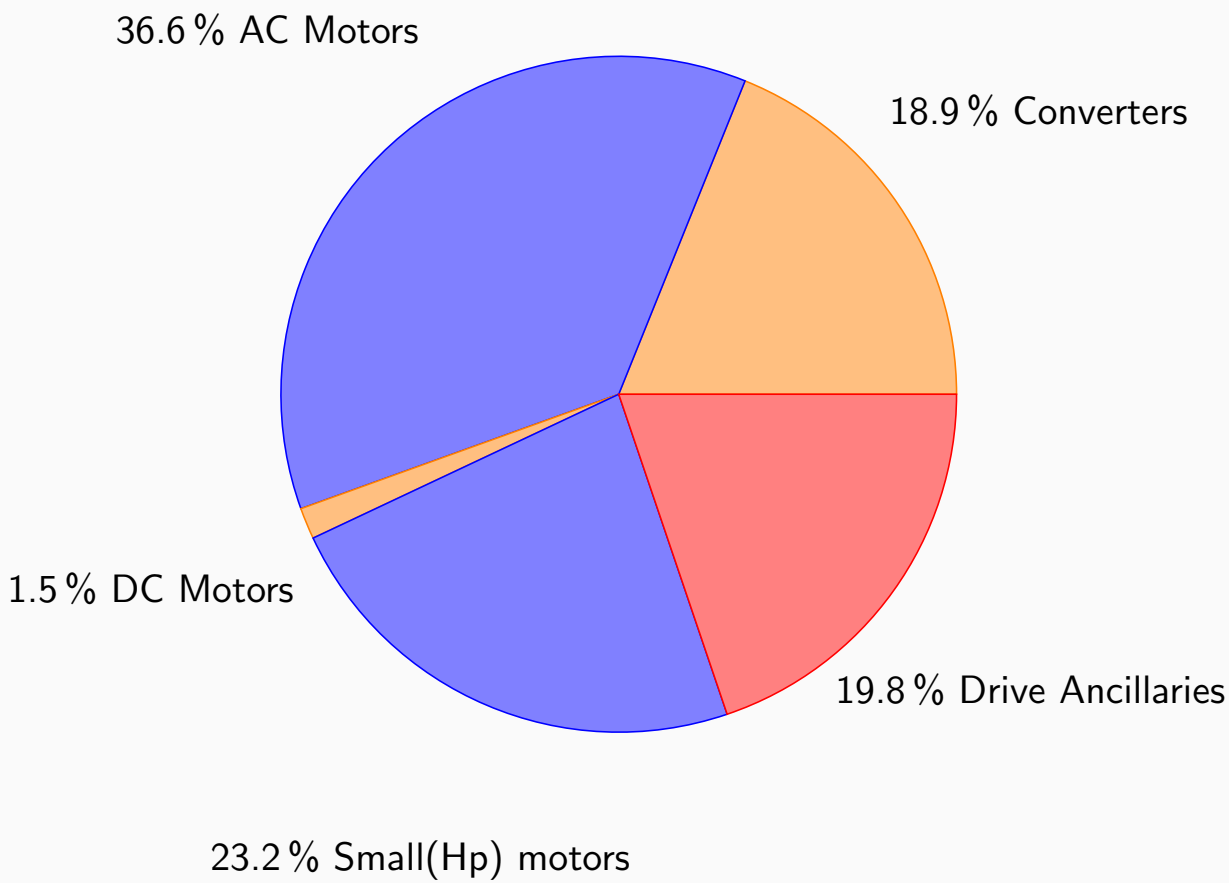
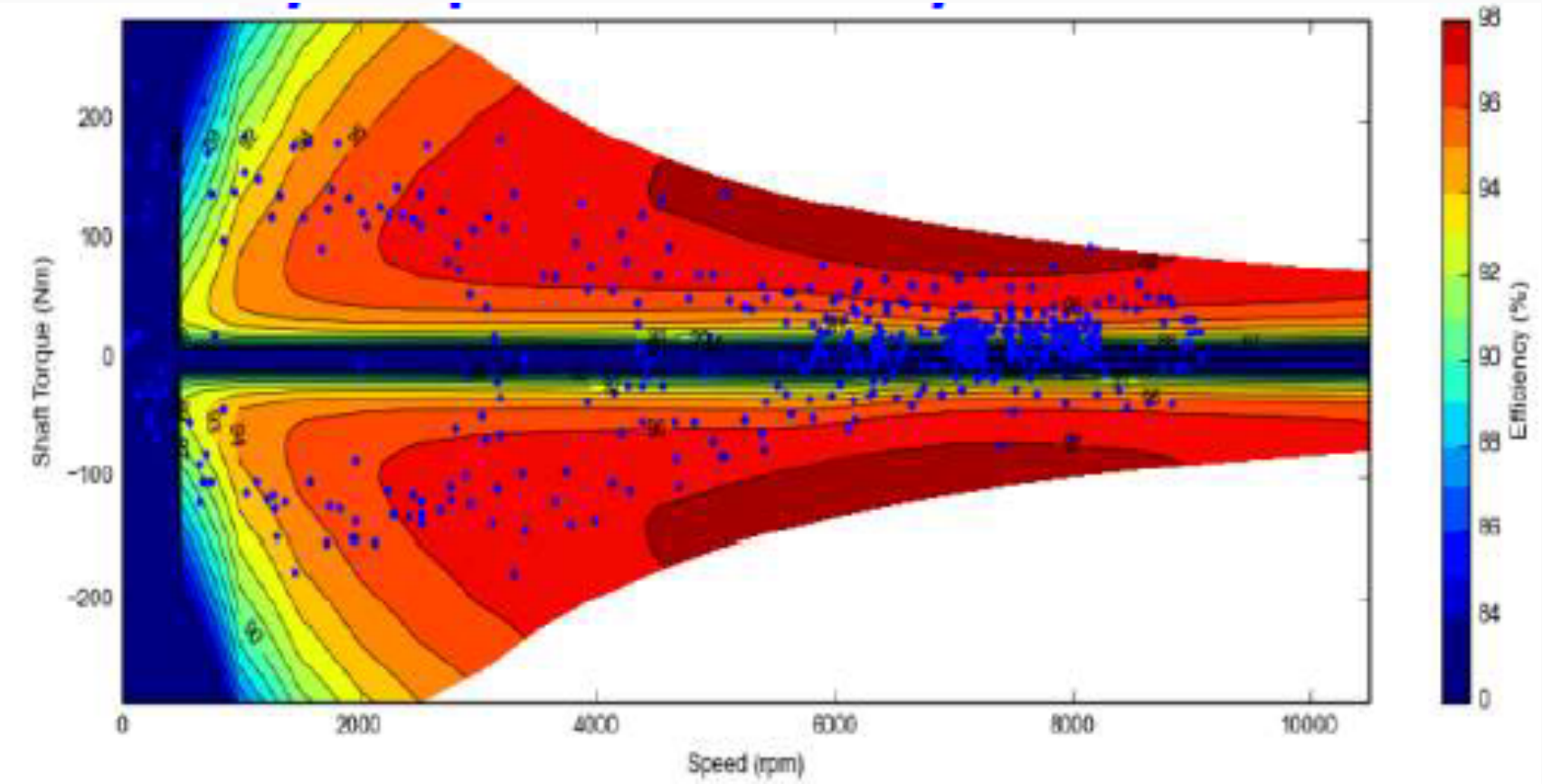


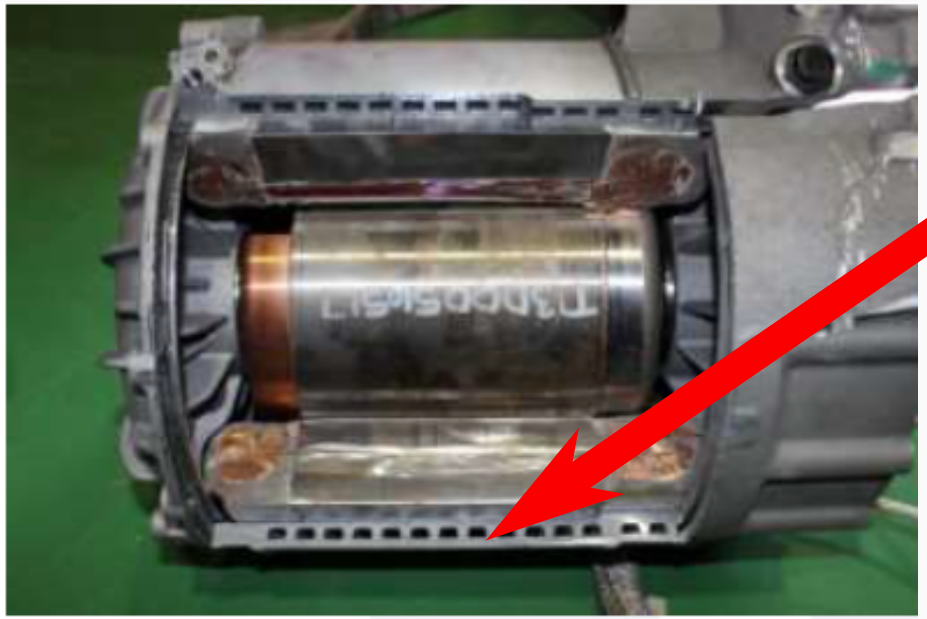
Figure 1: Production share of Electrical drive based on 2009 report by ZVEI

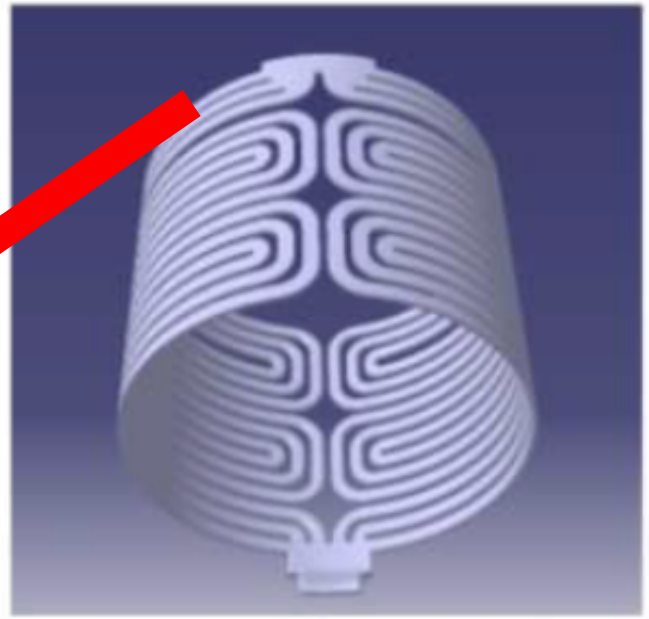
Nissan leaf performance

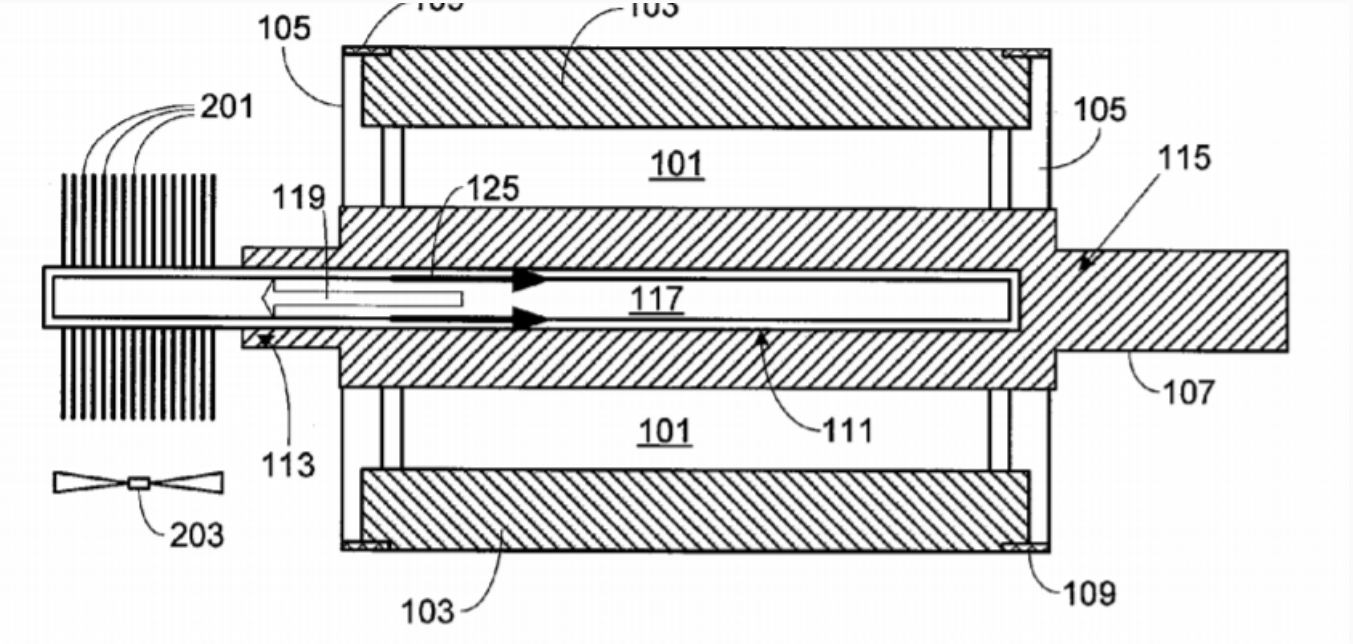


- Uses Interior Permanent Magnet Synchronous Motor
- Field Weakening (FW) range has to be large
- Design of IPM with large FW range is challenge

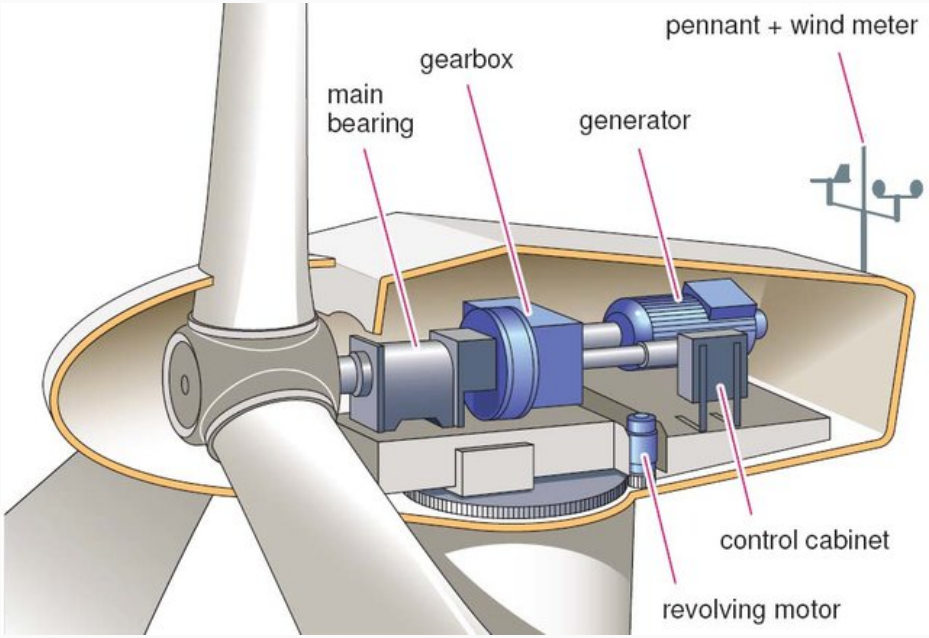
Tesla uses Induction motor





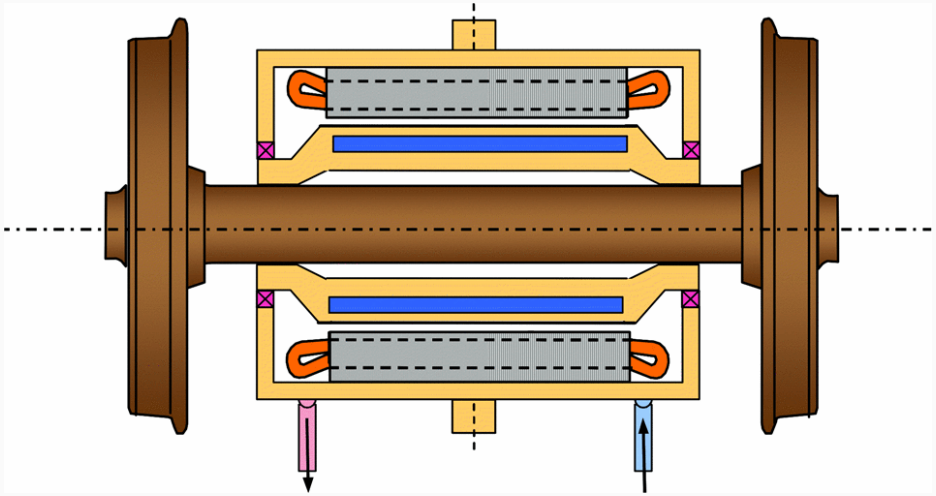


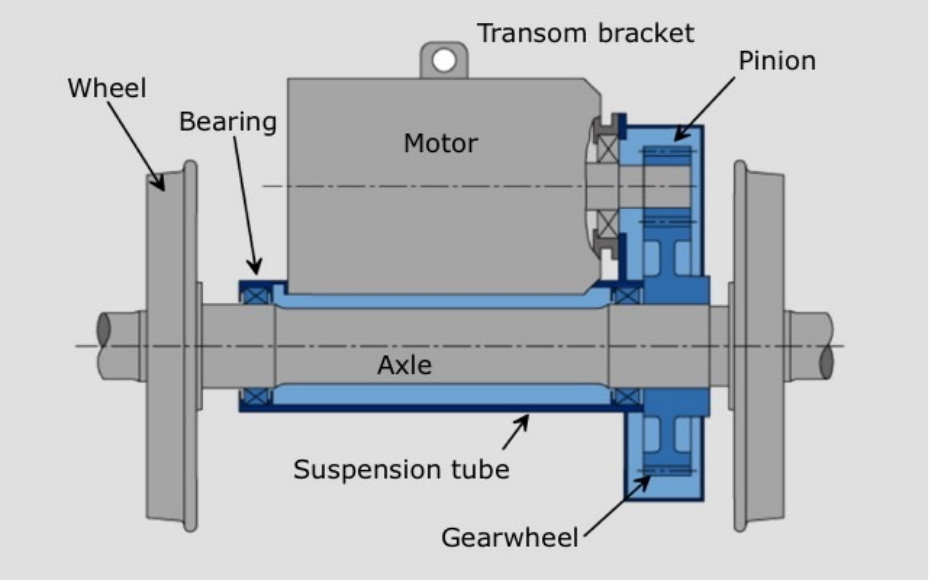
Wind Turbine Drives



- Early schemes used Doubly-Fed Induction Motors
- Induction Motors used with Rotor control
- Permanent Magnet Motors are also used
- Electric Machine acts as Generator
- Power Converters used for Control

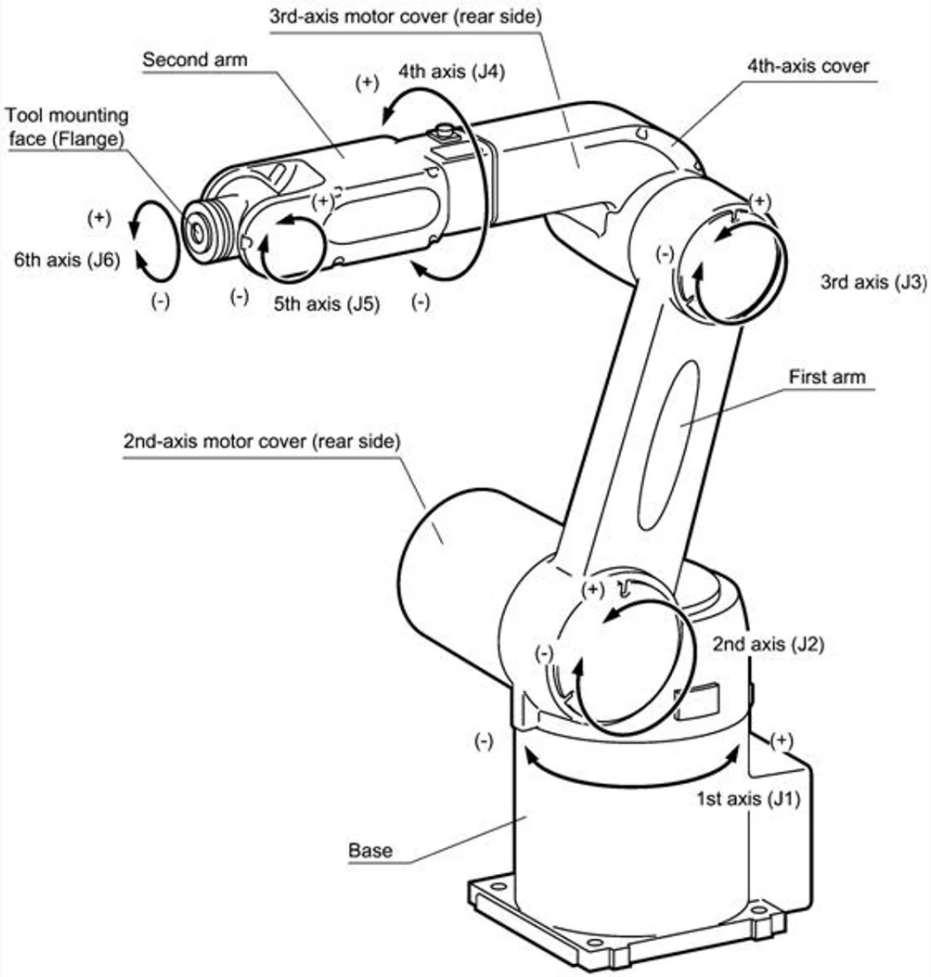
Traction Drives





- From MRTs to Shinkansen - Electric Motors needed
- Large Field-weakening range
- Fast Torque control

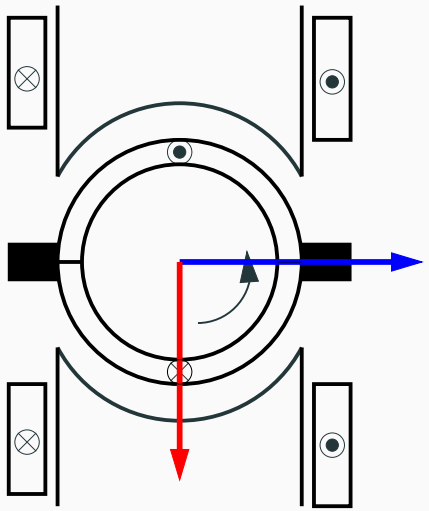
Robotic Applications



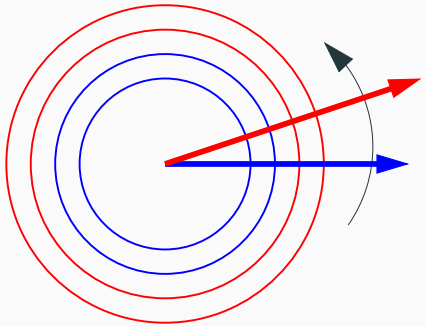
- Requires very good position control
- Cascaded control with inner Torque/Control used
- Machine has to be of small size
- Machine power density has to be high
- Or Torque to weight ratio has to be high

AC machines vs DC machines

- Stationary field due to field windings in DC machines



DC machine



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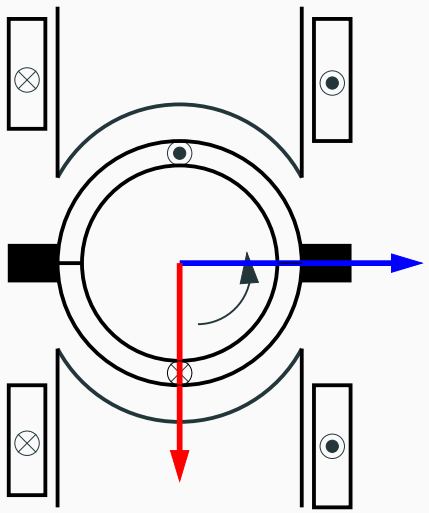
- Stationary field due to field windings in DC machines
- Armature current interacts with field to produce torque



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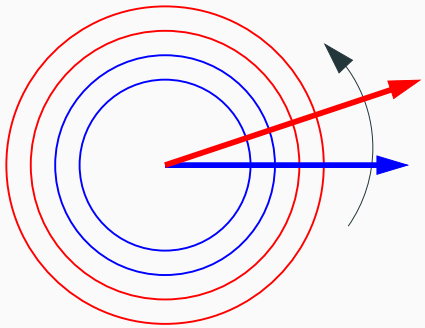

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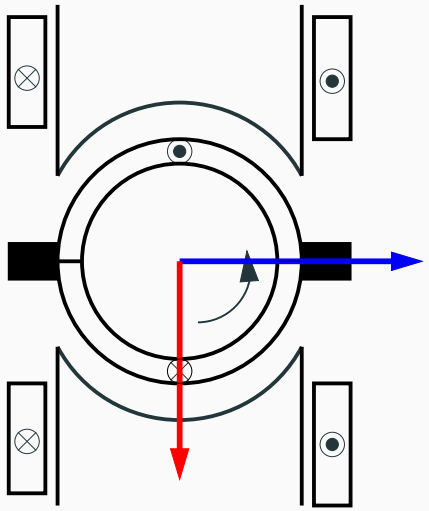

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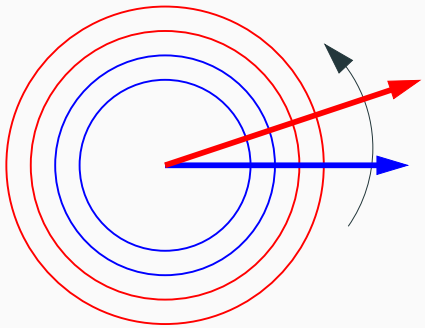

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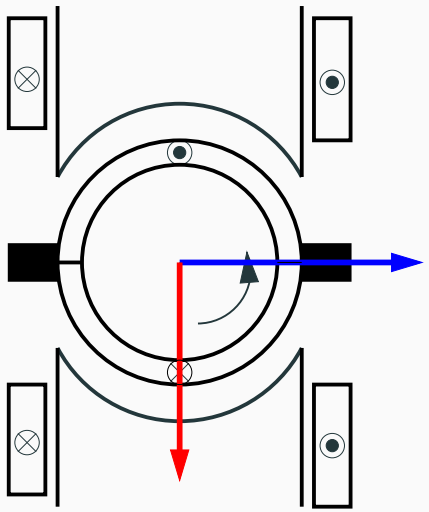

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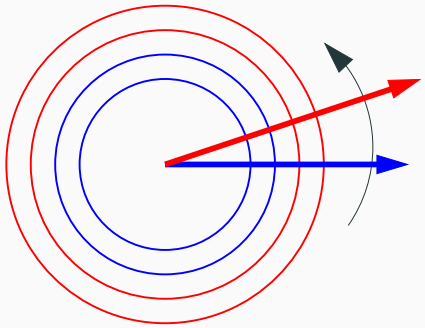

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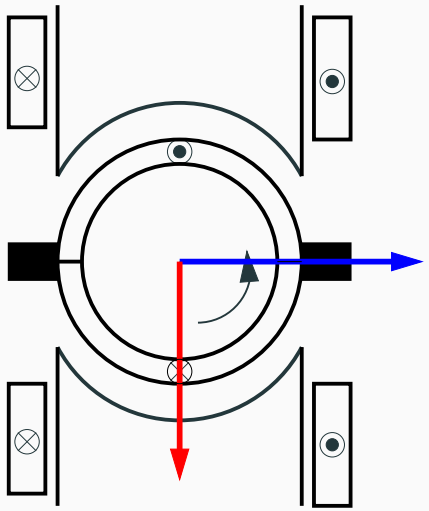

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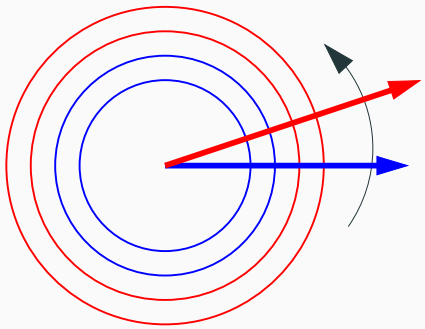

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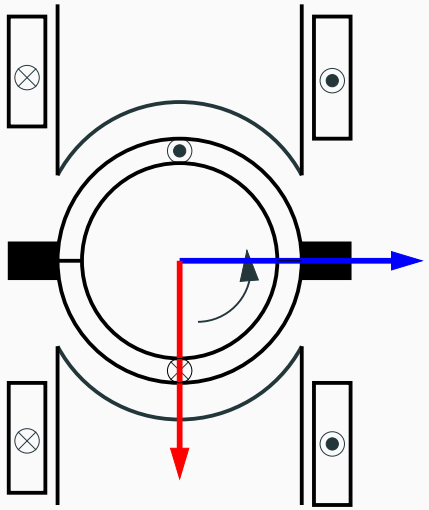
- **How to produce Rotating Field using AC? first step**



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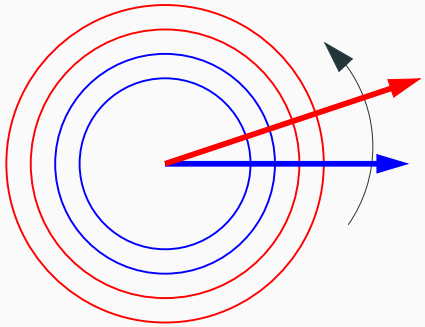
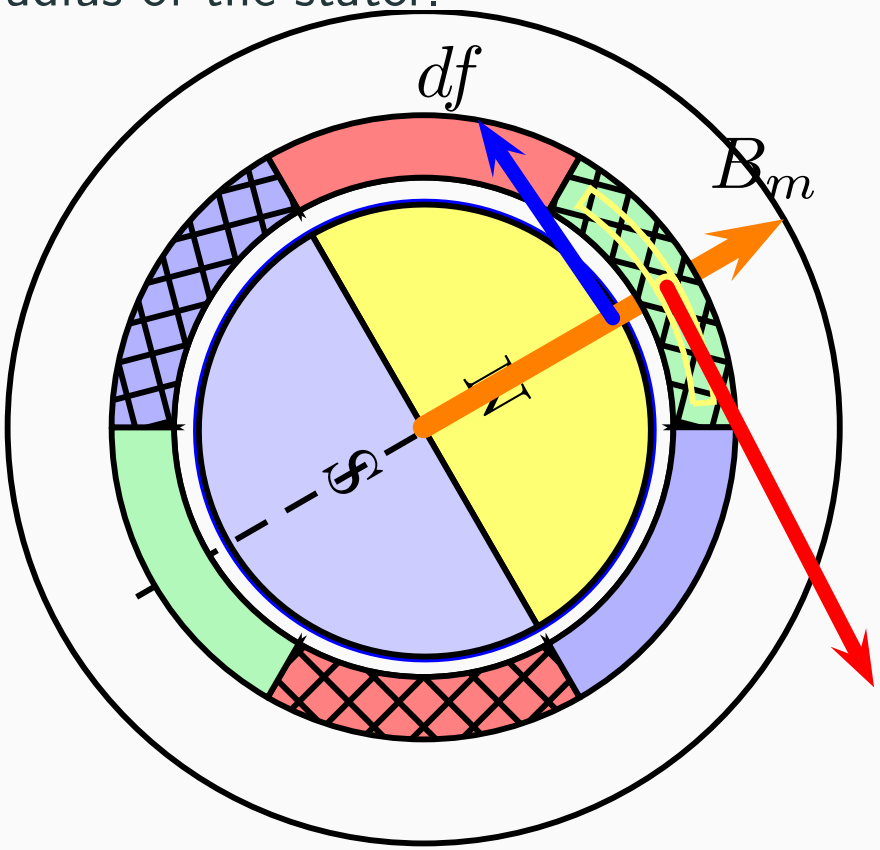


AC machine

Torque production in AC machine

A portion of the stator, $d\gamma_s$ will have a current $A_{s,1}(\gamma_s)rld\gamma_s$ coming out of the plane of the paper, where r is the radius of the stator and l its depth. This forms like a current sheet along the inner radius of the stator.



It interacts with the perpendicular flux density at that position on the stator, to produce a force.This will produces a tangential force on the stator and by reaction, an equal and opposite force on the rotor, given as

$$df = rl_e A_{s,1} \times \vec{B}_r d\gamma_s \tag{1}$$

To get the torque, we take the moment of the force which gives us $dM_e = rdf$

$$dM_e = rdf \tag{2}$$

$$dM_e = r^2 l_e B_{r,1} A_{s,1} d\gamma_s \tag{3}$$

What we need to find out next:

- How do we produce a rotating magnetic field?
- Since we have a 3 phase system how do we prodoces the rotating magentic field with 3 phase system?
- How does the 3 phase sytem help us in producing a torque?

References i